A MULTI-LAYER LINER

The present invention relates generally to a liner for use with a container closure, and specifically to a multi-layer liner incorporating a barrier function.

For many uses of closures, in particular the mineral water market, there are strict regulations relating to 'migration' from the packaging into the product. In the context of the present invention, migration originates from the movement (permeation) of molecules. In the case of a plastics closure, migration can relate to the ingress of molecules originating either from the outside atmosphere or from the closure itself. For example, oxygen can permeate inwardly from the outside atmosphere, and compounds from the plastics material itself can also permeate inwardly. A particular problem results from the degradation products of oxidation reactions, which can be promoted by sunlight. For example, when slip additives are oxidised aldehydes are produced; these are very soluble in water and produce an off-taste.

In the same way that inward migration can be undesirable, so can outward migration. For example, the outward migration of carbon dioxide from a carbonated beverage is undesirable.

Since most containers have inherently good barrier properties (e.g. glass, metal and modern plastics), attention is focused on improving the barrier properties of the plastics closure. It is therefore desirable to have a closure which reduces to a minimum the migration of molecules.

An effective way of preventing migration through a closure is to use a barrier layer in a liner. The

packaging industry considers aluminium to be an excellent barrier material. Aluminium is approved for use with food and beverages, it gives no flavour nor odour contamination and it is a moisture vapour and gas barrier.

Liners are commonly used in plastic container closures to help seal the container. These liners comprise several layers of which at least one will be a flexible layer in addition to the aluminium layer. This flexible layer is designed to deform as it is squeezed between the closure and the container to ensure a good seal over the container's opening. Accordingly, it is desirable for the liner as a whole to have sufficient flexibility to ensure adequate sealing. Since aluminium is a hard material its thickness is important, since if the layer of aluminium is too thick its inclusion in a liner may reduce the flexibility of the liner.

Further, when liners are used in closures it is desirable to reduce the friction between the liner and the underside of the closure so that the twisting action of the closure relative to the container, necessary to open the container, is as easy as possible. Accordingly, slip additives or agents are often added to the flexible layer. However, these slip additives are a source of aldehydes, as discussed above. Further, these slip additives can create problems of delamination (coming apart) of the multi-layer liners since they reduce the adhesion between the flexible layer and the aluminium layer. This delamination tends to occur when the finished

multi-layer liner is stamped or otherwise cut to shape prior to insertion into closures.

Accordingly, it is an object of the invention to provide a multi-layer liner which overcomes the above described problems. In other words, it is an object of the invention to provide a multi-layer liner which acts as a barrier to prevent the ingress of contaminants into the container from the liner itself, from the closure and from the environment outside the container. Further, it is an object of the invention to provide a layer which acts as a barrier preventing any of the product to egress from the closure. Finally, it is an object of the invention to provide a multi-layer liner which does not suffer from delamination.

In one aspect the invention provides an adhesive-less multi-layer liner for use with a container closure, comprising a flexible inert seal layer adapted to seal the liner against an associated container, an aluminium barrier layer for preventing molecules passing through the liner, and a flexible wadding layer, wherein the flexible inert seal layer and flexible wadding layer lie either side of the barrier layer and provide protection thereto, and wherein the flexible layer is co-extruded onto the barrier layer in at least two layers such that the layer furthest from the barrier layer comprises a slip additive and the layer nearest to the barrier layer comprises no slip additive.

In a further aspect, the invention provides a method of forming an adhesive-less multi-layer liner for use with a container closure, comprising the steps of

metallising a layer of metal of thickness less than 6μm onto a flexible inert seal layer, and co-extruding a flexible wadding layer onto the surface of the metal layer opposite from the flexible inert seal layer, wherein the flexible wadding layer is co-extruded onto the metal layer in at least two layers and the layer furthest from the metal layer comprises a slip additive and the layer nearest to the metal layer comprises no slip additive.

In a yet further aspect, the invention provides a method of forming an adhesive-less multi-layer liner for use with a container closure, comprising the steps of extruding a flexible inert seal layer onto a barrier layer, and co-extruding a flexible wadding layer onto the surface of the barrier layer opposite from the flexible inert seal layer, wherein the flexible wadding layer is co-extruded onto the barrier layer in at least two layers and the layer furthest from the barrier layer comprises a slip additive and the layer nearest to the barrier layer comprises no slip additive.

Further embodiments are disclosed in the dependent claims attached hereto.

The present invention and its advantages will be better understood by referring, by way of example, to the following detailed description and the attached Figures, in which;

Fig.1 is a section of a multi-layer barrier liner according to the present invention; and

Fig.2 is a section of a multi-layer barrier liner according to the present invention shown inserted into a container closure.

In the following text, the terms "upper" and "lower" and other such related orientational terms when referring to the liner and closure are used with reference to the liner as shown in the figures and also define the orientation of the liner in use. "Upper" refers to that part of the liner which, in use, is closest to the top plate of a closure; and "lower" refers to that part of the liner which, in use, is closest to the open end of the closure i.e. closest to the contents of a container.

In figure 1, there is shown a cross-section through a multi-layer barrier liner generally indicated 10. The upper layer 20 is a flexible layer acting as wadding and for providing a cushioning effect and therefore good seal qualities when the liner is used in conjunction with a closure and a container. This flexible wadding layer 20 also provides protection of the barrier layer 30, described below. This flexible wadding layer 20 may be comprised of ethyl vinyl acetate (EVA) or other suitable polymers such as flexible polyethylene and is typically of the order of 650μm in thickness.

Below the flexible wadding layer 20 is a barrier layer 30. This acts to prevent migration of molecules both upwardly and downwardly through itself. This layer may be aluminium. This aluminium may be in the form of a foil or a metallised layer, as discussed in more detail below.

Below the barrier layer 30 is a seal layer 40. This is the layer which will come into contact with the product inside the container. Accordingly, it is desirable for this layer to be as inert as possible. An example of such a material is a thermoplastic polyolefin, such as polyethylene. In film form this polyethylene provides a pure clean and flexible layer. It typically has a thickness of the order of 25μm.

The word "pure" is used in the sense that it has a minimum amount of additives to reduce or eliminate any migration of such additives into the product within the container. This inert seal layer 40 is also flexible to ensure that it may compress when squeezed between the closure shell and container to ensure that there is a good sealing effect.

Finally, a removable and sacrificial cover layer 50 is shown below the flexible inert seal layer 40. This cover layer 50 may comprise a polymer or other such material. Its purpose will be explained in more detail below.

A process of producing a multi-layer liner will now be described.

Firstly, the flexible inert seal layer 40 has a barrier layer 30 metallised onto its surface. This may be undertaken in several known ways. Although aluminium is typically used in this process it would be possible to use other known metals or metal/inorganic compounds. The thickness of this barrier layer 30 is typically less than 6μm. However, preferably this layer has a thickness in the range 30 to 100nm. Even more preferably this layer is

55nm in thickness. Since, the barrier layer 30 is metallised onto the surface of the flexible inert seal layer 40, there is no need for an adhesive layer therebetween. This has advantages of a reduction in the amount of materials required and a reduced stiffness of the overall liner 10.

Next, the flexible wadding layer 20 is extruded onto the surface of the newly created aluminium layer 30, on the side opposite from the flexible inert seal layer 40.

Optionally, before the flexible wadding layer 20 is extruded onto the surface of the aluminium layer 30, this aluminium surface may be subjected to corona treatment (or other such surface treatment) to improve adherence of the flexible wadding layer 20.

This flexible wadding layer (20) is produced by co-extruding two or more layers of material substantially simultaneously. All of these co-extruded layers have similar characteristics except that the upper-most layer has a slip additive or agent added to it and the lower-most layer has no slip additive or agent added to it. An example of a slip agent or additive is erucamide. Since these layers are co-extruded, in a manner well known to those skilled in the art, the layers will bond together and merge along their common boundaries to produce a single layer of material. By this bonding and merging, slip agent will migrate from the upper-most layer into the adjacent lower layers. However, this migration takes several hours or even days to reach the lower-most surface adjacent to the barrier layer 30. Accordingly, the slip agent will not interfere with the adherence of

the flexible wadding layer 20 to the barrier layer 30. Further, even when the slip additive migrates as far as this lower-most layer, adjacent to the barrier layer 30, once the adhesive bond between the barrier layer 30 and the flexible wadding layer 20 has formed, this adhesion will not be affected. As a consequence, delamination of the flexible wadding layer 20 from the barrier layer 30 is prevented since the adhesion of this flexible wadding layer 20 to the barrier layer 30 is improved by a factor of 10.

Further, the flexible wadding layer 20, when extruded, will adhere to the barrier layer 30 without need for any adhesive layer therebetween. This has advantages of a reduction in the amount of materials required and a reduced stiffness of the overall liner 10. However, if materials such as ethyl vinyl alcohol or polyethylene are used as the flexible wadding layer 20, an adhesive layer between the flexible wadding layer 20 and the barrier layer 30 would most likely be required. This would not cause any problems of contamination of the product since this layer 30 will act as a barrier to any molecules permeating inwardly from the adhesive layer.

Further still, this flexible wadding layer 20 acts to protect the barrier layer 30 which may be comparatively fragile and prone to damage or scratching if not protected.

Finally, a sacrificial cover layer 50 may be laid over the lower surface of the seal layer 40. This may take the form of a bi-axial oriented polypropylene of 50μm thickness. This requires no additional adhesive

layer between it and the seal layer 40 since there exists a naturally weak factor of adhesion between these two layers. This has the advantage of a reduction in the amount of materials required, a reduced stiffness of the overall liner 10, the elimination of any contamination of the seal layer 40 from adhesive, and a clean surface with no adhesive residue thereon after removal of this layer 50.

This sacrificial cover layer 50 has the effect that when the finished multi-layer liner 10 is rolled or otherwise handled prior to being fitted to the closure, there will be no contamination from the upper surface of the flexible wadding layer 20, which contains the maximum amount of slip additives, to the lower surface of the flexible inert seal layer 40, which will come into contact with the product within the container. Accordingly, in one embodiment this sacrificial cover layer 50 could instead lie above the flexible wadding layer 20, or both above and below the flexible inert seal layer 40.

A further possible way of producing the multi-layer liner is that this cover layer 50 is used as the base layer from which all other layers are built up in the manner described above. For instance, the seal layer 40 could be extruded onto the cover layer 50. Then the barrier layer 30 could be metallised onto the seal layer 40 and finally, the flexible wadding layer 20 could be co-extruded onto the barrier layer 30.

When the multi-layer liner 10 is stamped or otherwise cut to produce discs of liner for insertion

into closures, the cover layer 50 may be removed. This ensures that the flexible inert seal layer 40, which will be as clean and as uncontaminated as possible, is the layer which comes into contact with the product.

A yet further possible way of producing the multi-layer liner 10 is to start with a barrier layer 30 and to extrude the flexible inert seal layer 40 onto one side. The flexible wadding layer 20 is then co-extruded onto the opposite side of the barrier layer 30 in the same manner as described above. Optionally, before these two layers 20,40 are extruded onto opposite surfaces of the barrier layer 30, these barrier surfaces may be subjected to corona treatment (or other such surface treatment) to improve adherence thereto.

By extruding these two layers 20,40, no adhesive is required. This has advantages of a reduction in the amount of materials required and a reduced stiffness of the overall liner 10. However, it is possible to place a layer of adhesive between the flexible wadding layer 20 and the barrier layer 30 if necessary, since this layer 30 will act as a barrier to any molecules permeating inwardly from the adhesive layer.

Finally, the cover layer 50 is added to the underside of the flexible inert seal layer 40 in the same manner as described above. Alternatively, the cover layer 50 is added to the underside of the flexible inert seal layer 40 before the wadding flexible layer 20 is co-extruded onto the upper surface of the barrier layer 30. As described above, this sacrificial cover layer 50 could

also lie above the flexible wadding layer 20 instead, or as well as below the flexible inert seal layer 40.

In this embodiment the barrier layer 30 could be aluminium foil. However, other metals or metal compounds could be employed. The thickness of such a layer 30 preferentially lies in the range 6 to 20μm. If the barrier layer 30 is thicker than this it tends to be too stiff to allow the necessary flexibility of the finished liner.

A further embodiment of the multi-layer liner 10 has the same structure as described above (flexible wadding layer 20, flexible barrier layer 30, flexible inert seal layer 40 and cover layer 50), except that the flexible wadding layer 20 would be extruded as one layer rather than co-extruded as more than one layer. In this embodiment it would not be possible to eliminate slip additive from the lower surface of this flexible wadding layer 20. Accordingly, to improve the adhesion of this layer 20 to the barrier layer 30, an adhesive layer would be inserted therebetween. As discussed above, layer 30 will act as a barrier to any molecules permeating inwardly from the adhesive layer.

Although all of the various embodiments of the method of construction and of the multi-layer liner 10 have referred to extrusion or co-extrusion of certain of the layers, it should of course be understood that it would also be possible to use pre-formed layers of materials. These pre-formed layers could of course have been extruded or co-extruded in their formation.

Figure 2 shows a cross-section through a closure shell 60 wherein a multi-layer liner 10 has been fitted. The liner 10 has the same sequence of layers as shown in figure 1, except that the sacrificial cover layer 50 has been removed.